a1 cont'd

microphone disposed inside each said cavity and interconnected via a feedback loop including a constant gain amplifier [(11)] and a filter [(12)] with which they constitute an active sound attenuator, the apparatus being characterized in that the transfer function C(w) of said filter is a complex polynomial function and in that the product of the constant gain K of said amplifier [(11)] multiplied by the modulus $|C(w)|$ of the transfer function of said filter and by the modulus $|H(w)|$ of the open loop transfer function as measured at the input [(A)] to said transducer [(6)] and at the output [(B)] from said microphone [(8)] is considerably greater than unity throughout the range of low audio frequencies which are to be attenuated and satisfies the stability criterion for all audible frequencies.

Claim 8, Line 2, delete "(12)".

Claim 10, Line 2, delete "(11)".

a2 cont'd

~~11~~ 5. (Amended) Apparatus according to claim ~~7~~ 1, of the type in which each of said cavities includes a transverse partition [(7)] which divides it into two half-cavities, namely a front half-cavity and a rear half-cavity, said partition carrying said acoustic transducer, and in which said microphone [(8)] is disposed in said front half-cavity, the apparatus being characterized in that it further includes an annular part [(15)] which is interposed between said partition [(7)] and the pinna [(4)] of the ear and which delimits an intermediate cavity [(15a)], with the dimensions of said annular part [(15)] being designed so that the ratio between the dimensions of said

intermediate cavity and of said front and rear half-cavities gives rise to acoustic filtering having a pass band corresponding to the range of frequencies to be attenuated.

6 ~~12~~. (Amended) Apparatus according to claim 1 ~~7~~, characterized in that said microphone [(8)] is placed in the B ~~external~~ ear duct [(3)] and said transducer [(6)] is a miniaturized transducer whose covering on its rear face forms a plug which is engaged in the inlet to the external ear duct [(3)] such that said cavity is reduced to the volume delimited by the B ~~outer~~ ear duct [(3)], the eardrum [(16)], and the transducer [(6)], and such that the open loop transfer function H(w) is highly linear, enabling a good level of attenuation to be obtained over a wide frequency band B ~~by electronic filtering~~.

A2 cont'd

Claim 13, Line 1, delete "8" and insert therefor --17--.

Please add the following new claims:

7 ~~14~~. A method of attenuating external origin noise reaching the eardrum, comprising the following steps:

placing around each ear a passive soundproofing means which, together with the ear, delimits a cavity;

placing in each of said cavities an electro-acoustic transducer and a microphone;

electrically interconnecting said microphone and said transducer by an electronic feedback loop comprising a constant gain amplifier and a filter having a transfer function which is a complex polynomial function;

A3 cont'd

measuring the open loop transfer function H(w) of the assembly constituted by the transducer, the microphone and said cavity; and

calculating the coefficients of said polynomial function so that the product of the constant gain of said amplifier multiplied by the modulus of said open loop transfer function and by the modulus of the transfer function of said filter is much greater than unity over the range of low frequencies where said passive soundproofing means is of low effectiveness.

~~15~~ 11. A method of attenuating external origin noise reaching the eardrum, comprising the following steps:

placing around each ear passive soundproofing means which, together with the ear, delimits a cavity;

D3 cont'd

placing in each of said cavities an electro-acoustic transducer and a microphone;

electrically interconnecting said microphone and said transducer by an electronic feedback loop comprising a constant gain amplifier and a filter having a transfer function which is a complex polynomial function;

temporarily disconnecting said microphone from said transducer, applying an electric signal corresponding to white noise to the input of said transducer and measuring the open loop transfer function H(w) of the assembly constituted by said transducer, said microphone and said cavity by means of a spectrum analyzer which simultaneously receives said electrical signal and the electric signal emitted by said microphone; and

B1

calculating the coefficients of said polynomial function so that the product of the constant gain of said amplifier multiplied by the modulus of said open loop transfer function and by the modulus of the transfer function of said filter is much greater than unity over the range of low frequencies where said passive soundproofing means is of low effectiveness.

~~16~~ 12. A method according to claim ~~15~~ 11, further comprising the following steps:

sub-dividing said cavity into two half-cavities by a partition carrying said transducer;

interposing an annular part between said partition and the pinna of the ear; and

a3 cont.d

designing the shape and dimensions of said annular part so that it performs acoustical filtering giving an open loop transfer function having a low-pass filter or a band-pass filter function depending on the range of audio frequencies to be attenuated and placing said microphone in the half-cavity situated in front of said partition as close as possible to the emissive face of said transducer.

17. Apparatus for attenuating external origin noise reaching the eardrum comprising passive soundproofing means surrounding each ear which delimits with each ear a cavity, and further comprising an electro-acoustic transducer and a microphone which are disposed in each of said cavities and which are electrically interconnected via an electronic feedback loop including a constant gain amplifier and filter means having a complex polynomial transfer function wherein the product of the

constant gain of said amplifier multiplied by the modulus of said transfer function of said filter means and by the modulus of the open loop transfer function measured between the input electric signal to said transducer and the output electric signal from said microphone is much greater than unity over the range of low audio frequencies, and wherein said filter means comprises one or more analog filters of the band-pass type ~~or of the band-pass type~~ or of the band-pass and low pass type which are connected in parallel, which have a transfer function suitable for avoiding instabilities in the zone where the modulus is greatest.

B

B

16 ~~18~~. Apparatus for attenuating external origin noise reaching the eardrum comprising passive soundproofing means surrounding each ear which delimits with each ear a cavity, and further comprising an electro-acoustic transducer and a microphone which are disposed in each of said cavities and which are electrically interconnected via an electronic feedback loop including a constant gain amplifier and filter means having a complex polynomial transfer function wherein the product of the constant gain of said amplifier multiplied by the modulus of said transfer function of said filter means and by the modulus of the open loop transfer function measured between the input electric signal to said transducer and the output electric signal from said microphone is much greater than unity over the range of low audio frequencies and wherein said filter means comprises a plurality of analog filters of the low pass, band-pass and high pass types which are connected in parallel and have the same cut-off frequency and the same Q factor.

19. Apparatus for attenuating external origin noise reaching the eardrum comprising passive soundproofing means surrounding each ear which delimits with each ear a cavity, and further comprising an electro-acoustic transducer and a microphone which are disposed in each of said cavities and which are electrically interconnected via an electronic feedback loop including a constant gain amplifier and filter means having a complex polynomial transfer function wherein the product of the constant gain of said amplifier multiplied by the modulus of said transfer function of said filter means and by the modulus of the open loop transfer function measured between the input electric signal to said transducer and the output electric signal from said microphone is much greater than unity over the range of low audio frequencies and wherein the gain of said amplifier is positive and the transfer function of said filter means is determined such that the phase of said transfer function does not pass through the value zero in the pass-band of said filter means.

a3 cont'd

8 ~~20~~. A method according to Claim 7 ~~14~~, including the steps of attenuating externally originating noise with active soundproofing means placed at inlets to ears, permitting a message to be transmitted via an electro-acoustic path, applying electrical signals reflecting said message mixed with signals emitted by said microphone, applying said mixed signals via said amplifier to said transducer, and passing said signals through said filter.

13 ~~21~~. A method according to Claim 11 ~~15~~, including the steps of attenuating externally originating noise with active

soundproofing means placed at inlets to ears, permitting a message to be transmitted via an electro-acoustic path, applying electrical signals reflecting said message mixed with signals emitted by said microphone, applying said mixed signals via said amplifier to said transducer, and passing said signals through said filter.

9 ~~22~~. A method according to Claim 7 ~~14~~, characterized by sub-dividing said cavity into two half-cavities, a front half-cavity being delimited by the pinna of the ear, the external ear duct, the eardrum, and said partition, and a rear half-cavity delimited by said passive soundproofing means and said partition, said partition carrying said transducer, and placing said microphone in said front half-cavity as close as possible to the emissive face of said transducer.

14 ~~23~~. A method according to Claim 11 ~~13~~, characterized by sub-dividing said cavity into two half-cavities, a front half-cavity being delimited by the pinna of the ear, the external ear duct, the eardrum, and said partition, and a rear half-cavity delimited by said passive soundproofing means and said partition, said partition carrying said transducer, and placing said microphone in said front half-cavity as close as possible to the emissive face of said transducer.

10 ~~24~~. A method according to Claim 9 ~~22~~, characterized by reducing the volume of said cavity as much as possible in order to "linearize" said open loop transfer function H(w).

15 ~~25~~. A method according to Claim 14 ~~23~~, characterized by reducing the volume of said cavity as much as possible in order to "linearize" said open loop transfer function H(w).